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FIREKIT
A FIRE GROWTH SIMULATION and DISPLAY TOOLKIT

by

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FINAL REPORT for COOPERATIVE AGREEMENT
with SYSTEMS for ENVIRONMENTAL MANAGEMENT
#INT-88325

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Co-op Contact: Collin D. Bevins

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FIREKIT

A Fire Growth Simulation and Display Toolkit

Final Report
Cooperative Agreement
INT-88325-COA
Collin Bevins, SEM
In Cooperation with
Pat Andrews
RWU 4401
IFSL Missoula

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Missoula, MT

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0. PREFACE

Authorship

FIREKIT was programmed by Collin D. Bevins, Systems for Environmental Management, Missoula, MT. Program specifications were set by Patricia Andrews, USDA Forest Service, Intermountain Research Station, Missoula, MT.

This research was supported in part by funds provided by the U.S. Department of Agriculture, Forest Service, Intermountain Station.

Requirements

FIREKIT is a software tool box for researching wildland fuels and fire behavior. Program runtime requirements include:

- an IBM PC or 100% compatible,
- 512K bytes of free memory.
- an Intel 80286 or 80386 CPU,
- a matching Intel 80287 or 80387 math co-processor,
- an EGA, VGA, or Compaq VGA adapter and monitor, and
- MS-DOS 3.0 or later.

Manual Organization

1. **INTRODUCTION** describes FIREKIT's capabilities.

2. **CONCEPTS** describes the fundamental FIREKIT template and scoping concepts.

3. **COMMAND REFERENCE** describes all FIREKIT commands and documents their syntax.

4. **TECHNICAL DOCUMENTATION** describes FIREKIT file formats and fuel map bit switches.

5. **EXAMPLES** contains sample FIREKIT scripts.

6. **UTILITIES** describes the usage and outputs of the HEXPRINT and LPOINT programs.

1. INTRODUCTION

Capabilitieis

FIREKIT is a software toolkit for research in wildland fuels and fire behavior. It provides the tools necessary to (1) create and display wildland fuel mosaics and (2) simulate and display fire patterns within the fuel mosaic.

FIREKIT is a command-driven program. Commands may be (1) entered interactively from the keyboard or (2) stored in command script files for batch processing. The script files may be submitted at program startup time or interactively during a FIREKIT session.

FIREKIT consists of over 90 commands used to:

- o create fuel mosaics containing up to 16 fuel types,
- o define the size (span) of the fuel map,
- o draw fuel mosaics of arbitrary complexity using geometric primitives such as points, lines, ellipses, rectangles, and polygons,
- o draw fuel mosaics of arbitrary complexity using the cursor keys,
- o import fuel mosaics consisting of points, polylines, polygons, and ellipses from digitized files,
- o randomly assign fuel types based upon percent cover or random scatter parameters,
- o convert a fuel type to another fuel type,
- o assign one of 16 display colors and 32 patterns to fuel types,
- o display a fuel map at the console and interactively scroll, pan, zoom, and query the fuel map,
- o save a fuel map onto a disk file and load and overlay fuel maps from disk files,
- o assign standard or custom fuel models to fuel types,
- o assign or display fire environment variables (slope, aspect, wind speed and direction, and fuel moisture content),
- o select a fire growth algorithm (with or without penetration depth calculations or spread vector adjustment),

- ignite a fire of arbitrary shape and size in the fuel map,
- simulate and display fire growth and statistics within the fuel array.
- display fuel cell frequency by fuel type and fire status at any time during fire simulation,
- print the fire environment, fuel combustion, and/or fire statistics parameters at any time during fire simulation,
- interrupt the fire simulation at any time to interactively (1) construct fireline, (2) set backfire, (3) start spot fires, and/or (4) terminate the simulation,
- access the DOS command shell, execute DOS commands, display directories, and rename or delete files without leaving FIREKIT,
- interactively browse text files,
- send text and/or printer control strings to output files or devices,
- redirect input from nested script files and/or redirect output to log or NULL files,
- display command help information,
- document and display the user and map description,
- set the console video mode,
- reset and display an internal stopwatch, and
- control the FIREKIT command environment (command echo, prompt, abort, and confirm switches).

Program Installation and Startup

The following files are used to run the FIREKIT program:

FIREKIT.EXE Required FIREKIT executable program. Must be in the current directory or referenced by the PATH environment string.

FIREKIT.SCR Optional FIREKIT startup script file. When FIREKIT is first invoked from the DOS prompt, it searches for FIREKIT.SCR in the current directory. If found, it executes the commands contained in the file. This is a convenient place to keep standard startup command sequences such as VIDEO, ECHO, PROMPT, USER, and so forth.

FIREKIT.HLP Required FIREKIT HELP text file. This file is required only if you plan to use the HELP command. You may use alternate help files via the ATTACH HELP command.

FIREKIT.MOD Required Fuel Model Catalog File. This file is required only if you plan to use the FUEL command (and by extension, if you wish to simulate fire growth). You may use alternate fuel model catalog files via the ATTACH MODEL command.

To install FIREKIT, simply copy the above 4 files onto your hard disk.

To start the FIREKIT program from the DOS prompt, enter:

C> FIREKIT

FIREKIT displays the startup banner, reads and processes the FIREKIT.SCR file (if it exists), and prompts for a command. You need enter only the first 4 characters of FIREKIT commands.

To terminate FIREKIT, enter QUIT at the prompt:

?> QUIT

2. CONCEPTS

Templates

FIREKIT maintains an internal fuel array map containing a maximum of 14,000 cells in 140 columns and 100 rows. Each fuel cell has two attributes; its **fuel_id** and **template switch.**

Fuel_ids are simply integers in the range [0-15]. FIREKIT commands allow you to associate fuel_ids with plot symbols, display colors and patterns, and fuel models.

The template switch determines whether or not the cell is in the template. FIREKIT drawing commands (such as CELL, CIRCLE, LINE, IMPORT, and RECTANGLE) describe a set of cells within the fuel array. Cells within the set have their template switches set on (or off) by the drawing command. A series of drawing commands is issued to create a template of arbitrary shape and complexity.

By default, the drawing commands add cells to the template. If a negative sign (-) is appended to the drawing command, however, the cells within the geometric form have their template switches set off. This makes it possible to create templates containing 'holes'.

A cell's template switch determines whether or not it is included in the scope of a command. Commands whose scope are affected by the template switch include: CONVERT, COVER, FREQUENCY, PASTE, PLOT, SCATTER, and VIEW.

A cell's template switch also determines whether it is ignited at the beginning of a fire simulation. Cell's whose template switch is ON are assigned an ignition time of 0.

Scope

The fuel assignment commands (such as CONVERT, COVER, and SCATTER) and display commands (such as FREQUENCY, PLOT, and VIEW) can operate on:

- o the entire fuel array.
- o only those cells within the template, or
- o only those cells outside the template.

By default, the **scope** of each command is the entire fuel array. If a plus sign (+) is appended to the command, its scope is restricted to those cells within the template (e.g., cells whose template switch is on). If a negative sign (-) is appended to the command, its scope is restricted to those cells outside the template (e.g., cells whose template switch is off).

The **inclusive** and **exclusive** scope operators (plus and negative signs, respectively) are very useful for displaying, altering, and summarizing the current template.

Templates can be saved to a disk file (using SAVE+) and loaded from a disk file to any fuel array offset (using OVERLAY).

The CLEAR command sets all fuel array template switches off, and is used before constructing a new template.

```
ABORT [ { ON | OFF } ]

ASPECT [ <down_slope_bearing> ]

ATTACH { HELP | MODELS } [ <unambiguous_file> ]

BEARING [ <wind_bearing> ]

BROWSE <unambiguous_file>

BURN[{+|-}]   [ UNTIL  { { CELLS <cells_burned> }
                       | { IGNITES <ignited_cell_column> <ignited_cell_row> }
                       | { MINUTES <minutes> }
                       }
              ]

CELL[-] <column> <row>

CIRCLE[-] <column_center> <row_center> <radius>

CLEAR

CLS

COLOR [ { <fuel_id> <color_name> }+ ]

COMBUSTION [ <unambiguous_file> ]

CONFIRM  [ { ON | OFF } ]

CONTINUE[{+|-}] [ UNTIL  { { CELLS <cells_burned> }
                         | { IGNITES <ignited_cell_column> <ignited_cell_row> }
                         | { MINUTES <minutes> }
                         }
                ]

CONVERT[{+|-}] { <old_fuel_id> <new_fuel_id> }+

COVER[{+|-}] { <fuel_id> <coverage> }+

CYCLES [ <cycles_per_minutes> ]

DELETE { <unambiguous_file> }+

DESCRIPTION [ <string> ]

DIAMETER [ <cell_diameter> ]

DIRECTORY [ { <ambiguous_file> }+ ]
```

DISPLAY [{ FIRE | FUEL }]

ECHO [{ ON | OFF }]

ELAPSED [<unambiguous_file>]

ELLIPSE[-] <column_center> <row_center> <column_radius> <row_radius> <angle>

ENVIRONMENT [<unambiguous_file>]

FREQUENCY[{+|-}] [<unambiguous_file>]

FUELS [{ <fuel_id> <model_label> }+]

GBURN[{+|-}] [UNTIL { { CELLS <cells_burned> }
| { IGNITES <ignited_cell_column> <ignited_cell_row> }
| { MINUTES <minutes> }
}]

GCONTINUE[{+|-}] [UNTIL { { CELLS <cells_burned> }
| { IGNITES <ignited_cell_column> <ignited_cell_row> }
| { MINUTES <minutes> }
}]

GLEGEND

HELP { <command> | <topic> }

IMPORT <unambiguous_file> [{ <x_offset> <y_offset> <conversion_factor> }]

LEGEND [{ <fuel_id> <color_name> <pattern> <symbol> }+]

LINE[-] <column_begin> <row_begin> <column_end> <row_end>

LOAD <unambiguous_file>

LOGFILE [{ ON | OFF | <unambiguous_file> }]

MAGNIFY [<pixels_per_cell>]

MESSAGE [<string>]

MODE [{ BATCH | INTERACTIVE }]

MOISTURE [<1_hr_%> <10_hr_%> <100_r_%> <herb_%> <woody_%> }]

NEIGHBORS [{ 6 | 8 }]

ORIGIN [<column_begin> <row_begin>]

OVERLAY[-] <unambiguous_file> [<column_offset> <row_offset>]

PANEL [<columns> <rows>]

PASTE[{+|-}] <unambiguous_file> [<column_offset> <row_offset>]

PATTERN { <fuel_id> <pattern_id> }+

PAUSE [{ OFF | ON | <seconds> }]

PEEK <unambiguous_file>

PENETRATION [{ ON | OFF }]

PERIMETER[-] <column_center> <row_center> <col_radius> <row_radius> <angle>

PLOT[{+|-}] [<unambiguous_file>]

PROCEDURE <system_command_line>

PROMPT [{ ON | OFF }]

QUIT

RECTANGLE[-] <column_begin> <row_begin> <columns> <rows>

REDIRECT <unambiguous_file>

RENAME { <old_unambiguous_file> <new_unambiguous_file> }+

REPORT [{ { COMBUSTION | ENVIRONMENT | SPREAD } <minutes> <file> }]

RESET

SAVE[{+|-}] <unambiguous_file>

SCATTER[{+|-}] { <fuel_id> <probability> }+

SCREEN [{ <foreground_color> <back ground_color> }]

SCRIPT [<unambiguous_file>]

SEED [<seed_value>]

SEND <unambiguous_file> { <ascii_decimal_code> }+

SHELL

SLOPE [<%_slope>]

SPAN [<columns> <rows>]

SPREAD [<unambiguous_file>]

SQUARE[-] <column_begin> <row_begin> <columns>

SYMBOL [{ <fuel_id> <symbol> }+]

TEMPLATE [{ CLEAR | ON | OFF }]

TERRAIN [{ <%_slope> <down_slope_bearing> }]

TEXTMODE

TIME [<unambiguous_file>]

TYPE { <unambiguous_file> }+

UNDIRECT

UNDO

UNITS [{ ENGLISH | FORESTRY | METRIC }]

UPDATE

USER [<string>]

VELOCITY [<wind_mph>]

VERSION [<unambiguous_file>]

VIDEO [{ CVGA | EGA | VEGA }]

VIEW[{+|-}]

WIND [{ <wind_mph> <wind_bearing> }]

WRITE <unambiguous_file> <string>

ABORT — Displays or sets the ABORT switch ON or OFF. When ABORT is ON, FIREKIT terminates whenever an error condition is detected (such as incorrect command syntax or inability to perform i/o). When ABORT is OFF, FIREKIT returns to the command prompt whenever an error condition is detected.

ABORT is normally set OFF during INTERACTIVE MODE processing, and is set ON during BATCH MODE processing.

ASPECT — Displays or sets the current terrain aspect. Aspect is expressed as compass degrees in the down slope direction (a south aspect has a value of 180). Aspect defaults to 0 at program startup, and may be reset at any time, even during a fire simulation. The TERRAIN command also displays or sets the slope aspect.

ATTACH — Displays or sets the current HELP or fuel MODEL files. The default values are FIREKIT.HLP and FIREKIT.MOD, respectively.

BEARING — Displays or sets the current wind direction. Bearing is expressed as compass degrees in the direction of wind flow (a northerly wind, which flows in a southerly direction, has a bearing of 180). Bearing defaults to 0 degrees at program startup, and may be reset at any time, even during a fire simulation. The WIND command also displays or sets the wind bearing.

BROWSE — Permits browsing of any MS-DOS text file. The file name and displayed lines numbers are shown at the top of the screen. The cursor keys used to BROWSE through the file are displayed at the bottom of the screen.

BURN — BURN is the text mode (non-graphical) fire simulator. Fire time and cell status (unburned, burning, burned) are output in table format during BURN processing. See GBURN for a more complete discussion.

CELL — Switches the designated cell's template bit according to FIREKIT command scoping rules.

CIRCLE — Switches the template bits of all cells within the designated circle according to FIREKIT command scoping rules.

CLEAR — Switches OFF the template bits of all map cells.

CLS — Clears the display screen.

COLOR — Displays or sets the colors associated with fuel_ids, burning and burned cells, and the interactive draw mode. The fuel_ids are referenced by numbers 0-15. Burning and burned cells are referenced by number 16 and 17, respectively. The interactive draw color is referenced by number 18.

Colors are referenced by name: BLACK, BLUE, GREEN, CYAN, RED, MAGENTA, BROWN, and WHITE. Prefix the letter 'I' to any name to get the high intensity version of the color.

COMBUSTION — Calculates and displays fuel combustion variables (residence time, reaction intensity. and spread to all neighbors) using the current fire environment and fuel model assignments. The combustion table is optionally printed to a designated disk file. Use the REPORT command to periodically print combustion tables during fire simulation.

CONFIRM — Displays or sets the CONFIRM switch ON or OFF. When CONFIRM is ON, FIREKIT displays a confirmation message at the completion of every command. The confirmation is in addition to the standard output generated by a command.

CONTINUE — CONTINUE resumes a BURN or GBURN fire simulation in text mode. New combustion variables are computed before resuming the simulation in case the fire environment or fuel assignments have been altered. The fire simulation continues from when and where it was interrupted. A new interrupt may be scheduled on the CONTINUE command line.

CONVERT — Translates the specified fuel_ids to their replacement values according to FIREKIT command scoping rules.

COVER — Assigns fuel_ids to all cells within the command scope. The fuel_ids are assigned with probability proportional to their respective coverage values.

CYCLES — Displays or sets the fire simulation time resolution. CYCLES are expressed as units per minute. The default value is 600 cycles per minute.

DELETE — Deletes all files matching the designated ambiguous file specification.

DESCRIPTION — Displays or sets the Raster Fuel Map description string.

DIAMETER — Displays or sets the cell diameter used during fire simulation. The default value is 10 feet.

DIRECTORY Displays the name, size, time, and date of all files matching the designated ambiguous file specifications.

DISPLAY Displays or sets the DISPLAY switch to FIRE or FUEL. When DISPLAY is set to FUEL, the VIEW and PLOT commands display cells using their fuel_id colors, patterns, and symbols, regardless of whether or not they are unburned, burning, or burned out. When DISPLAY is set to FIRE, the VIEW and PLOT commands display all unburned cells as described above. Burning and burned out cells, however, are displayed using the burned and burned out colors, patterns, and symbols. DISPLAY defaults to FUEL at program startup.

ECHO Displays or sets the ECHO switch ON or OFF. When ECHO is ON, the command line is echoed back to the standard output device. ECHO is normally OFF during INTERACTIVE MODE processing, and ON during BATCH MODE processing.

ELAPSED Displays the elapsed time since program startup or since the most recent RESET command. Elapsed time is optionally displayed to the designated file.

ELLIPSE Switches the template bits of all cells within the designated ellipse according to FIREKIT command scoping rules.

ENVIRONMENT Displays a table of fire environment variables to the terminal or to the optionally designated file. Displayed variables include terrain aspect and slope, wind speed and bearing, fuel moisture contents, fuel model assignment, map neighbors, and penetration depth options. Use the REPORT command to periodically display fire environment variables during fire simulation.

FREQUENCY Calculates and displays cell frequencies by fuel_id and fire status (unburned, burning, burned out) according to FIREKIT command scoping rules. The frequency table is optionally displayed to the designated disk file.

FUELS Displays or assigns fuel models to the designated fuel_ids. The fuel models are identified by their 1-8 character label, which must be present in the current fuel model file. The ATTACH FUEL command is used to establish the fuel model catalog file.

GBURN

GBURN is the graphics mode fire simulator. Fire is simulated in the current fuel array using the current fuel model and fire environment assignments.

The following conditions affect the fire simulation:

1. All fuel_ids in the fuel array not specifically assigned to a fuel model (via the FUEL command) default to NOFUEL (incombustible).

2. The current terrain SLOPE and ASPECT, wind VELOCITY and BEARING, fuel MOISTURE, map NEIGHBORS, cell DIAMETER, and PENETRATION values are used.

3. All cells whose template bit is ON are ignited at the beginning of the simulation. Before issuing the BURN or GBURN commands, you should CLEAR the template, then create an ignition pattern template. The template is automatically cleared when BURN terminates.

BURN may be interrupted at any time by pressing the <Esc> key or by scheduling an interrupt. Interrupts are scheduled from the command line using the UNTIL clause. Schedules interrupts occur whenever:

1. the designated time (in minutes) has passed,

2. the designated cell has ignited, or

3. the designated number of cells have ignited.

During an interrupt, you may:

1. return to text mode, issue a series of commands (perhaps to change wind or moisture variables), then continue the simulation using the CONTINUE or GCONTINUE commands,

2. query the fuel_id and fire status of any cell by positioning the cursor,

3. draw, erase, and save fire control line, backfired line, or spot fires using the penup/pendown < 1>, draw/erase < 2>, save < 3>, and line/torch < 7> keys,

4. change the fire simulation mode between step and flow modes using the < 6> key. and

5. continue the fire simulation by pressing the < 5> key or terminate the simulation by pressing the <Esc> key.

Upon return from the interrupt, FIREKIT again calculates all combustion variables in case the fire environment has changed. The simulation continues with all saved fireline, backfire, and spot fires, until all burnable cells have ignited.

GCONTINUE GCONTINUE resumes a BURN or GBURN fire simulation in graphics mode. New combustion variables are computed before resuming the simulation in case the fire environment or fuel assignments have been altered. The fire simulation continues from when and where it was interrupted. A new interrupt may be scheduled on the GCONTINUE command line.

GLEGEND Shows a graphical display of the current COLOR, PATTERN, and SYMBOL attributes associated with each fuel_id and fire status.

HELP If no argument (or an invalid argument) is given, displays a list of all FIREKIT commands. If a valid FIREKIT command is given as the argument, the command's syntax and description is displayed.

IMPORT Loads the designated import file into the fuel array. The import file contains one or more CIRCLE, ELLIPSE, LINE, POINT, or POLYGON features.

Each feature begins with a free-format header record containing the feature type (CIRCLE, ELLIPSE, LINE, POINT, or POLYGON) and the number of following coordinate records. For CIRCLE, ELLIPSE, and POINT features, more than one coordinate record may appear after a header, in which case each record describes an individual feature. For LINE and POLYGON features, each coordinate record specifies a segment of that feature, and one header record must appear for every feature.

Each free-format coordinate record contains two or more integer or floating point numbers in world coordinates:

CIRCLE	<x_center> <y_center> <radius>
ELLIPSE	<x_center> <y_center> <x_radius> <y_radius> <rotation angle>
LINE	<x> <y>
POINT	<x> <y>
POLYGON	<x> <y>

If the optional <x_offset>, <y_offset>, and <conversion_factor> arguments are given with the IMPORT command, the coordinates are adjusted before conversion as follows:

column = 1 + INT(conversion * (x + x_offset))
row = 1 + INT(conversion * (y + y_offset))

CIRCLE and ELLIPSE radii are affected by the conversion factor, but not by the x- or y-offsets. The ELLIPSE rotation angle is unaffected by either the conversion factor or the offsets.

LEGEND — Displays or sets the colors, patterns, and symbols associated with fuel_ids, burning and burned cells, and the interactive draw mode. The fuel_ids are referenced by numbers 0-15. Burning and burned cells are referenced by number 16 and 17, respectively. The interactive draw color is referenced by number 18.

Valid color names are listed under the COLOR, PATTERN, and SYMBOL commands, respectively. The colors and patterns are used by the VIEW, BURN and GBURN commands while the symbols are used by the PLOT command.

LINE — Switches the template bits of all cells lying on the line between the two designated points according to FIREKIT command scoping rules.

LOAD — Loads a previously SAVEd raster fuel map file into the fuel array. Any existing fuel array is discarded.

LOGFILE — Displays or sets the log file name, or switches log file recording ON or OFF. When LOGFILE is ON, all output and confirmation messages are duplicated to the log file.

MAGNIFY — Displays or sets the VIEW and GBURN magnification factor. Magnification is expressed as the number of pixels per side for a single cell. A magnification of 4 displays cells containing 16 pixels.

MESSAGE — Displays or sets the message string displayed at the top of the VIEW and GBURN map window.

MODE — Switches command processing mode between BATCH and INTERACTIVE. When MODE is BATCH, ABORT and ECHO are set ON, and PROMPT is set OFF. When MODE is INTERACTIVE, ABORT and ECHO are set OFF, and PROMPT is set ON.

MOISTURE — Displays or sets the fuel moisture contents for 1-hour, 10-hour, 100-hour, herbaceous, and live woody fuels. Moisture contents are expressed as a percent of oven dry weight.

NEIGHBORS — Displays or sets the number of neighboring cells to which fire can spread during the fire simulation. A value of 6 implies a hexagonal array while a value of 8 simulates a grid array.

ORIGIN — Displays or sets the column and row origin cell (lower left-hand corner) for VIEW and GBURN. Used mostly during batch processing.

OVERLAY — Overlays the template pattern from the designated SAVEd raster fuel map file onto the current fuel array. The overlaid template may optionally be offset by a specified number of rows and columns.

PANEL — Displays or sets the maximum columns and rows per PLOT panel.

PASTE — Overlays the fuel_ids from the designated SAVEd raster fuel map file onto the current fuel array. The overlaid fuel_ids may optionally be offset by a specified number of columns and rows.

PATTERN — Displays or sets the patterns associated with fuel_ids, burning and burned cells, and the interactive draw mode. The fuel_ids are referenced by numbers 0-15. Burning and burned cells are referenced by number 16 and 17, respectively. The interactive draw color is referenced by number 18. Valid patterns are:

PAUSE — Displays or sets the PAUSE switch and seconds. PAUSE is used during BATCH processing to pause the VIEW display before executing the next command.

PEEK — Displays the USER, DESCRIPTION, and SPAN of a previously SAVEd raster fuel map file.

PENETRATION Displays or sets the PENETRATION switch ON or OFF. When PENETRATION is set ON, fire penetration depths are calculated and taken into account during fire spread simulation and statistics reporting. This is appropriate when cell diameter is the same magnitude as the fire front depth.

PERIMETER Switches the template bit of cells lying along the perimeter of the designated ellipse according to FIREKIT command scoping rules.

PLOT Plots a text mode fuel array map to the console or optionally to the designated disk file. PLOT is affected by the DISPLAY setting, PANEL setting, SYMBOL settings, and FIREKIT command scoping rules.

PROCEDURE Executes the remaining arguments as a single MS-DOS command just as if the command were issued from the DOS prompt. Warning: since FIREKIT occupies 500K of memory. and DOS occupies another 100K, there isn't much room left to execute program larger than 40K. See also the SHELL command.

PROMPT Displays or sets the PROMPT switch ON or OFF. When PROMPT is ON, the user is prompted for input by the '?' or '*?' prompts. The latter prompt indicates that TEMPLATE is set ON. PROMPT is set ON during INTERACTIVE MODE processing, and is set OFF during BATCH MODE processing.

QUIT Instructs FIREKIT to close all files and terminate back to DOS.

RECTANGLE Switches the template bits of all cells lying within the designated rectangle according to FIREKIT command scoping rules.

REDIRECT Redirects all FIREKIT output, including prompts, standard output, and confirmation messages, to the designated file. Its primary use is for BATCH or SCRIPT processing when you don't want the VIEW to be constantly interrupted by TEXTMODE commands.

For self-running VIEW scripts, issue REDIRECT NULL to route all output to the great void. Subsequent commands, followed by the UPDATE command, will update the VIEW without switching back and forth between VIEW and TEXT modes. When script processing is completed, nothing will appear on the screen until an UNDIRECT command is given.

RENAME — Renames the existing MS-DOS files to the designated new names.

REPORT — Displays or sets the REPORT type, file, and frequency during BURN and GBURN processing. There are three valid reports, COMBUSTION, ENVIRONMENT, and SPREAD, which may be displayed to the same or separate files. Display frequency is expressed as minutes. A negative display frequency turns the reporting feature off for that table. The REPORT command must be given individually for each report type.

RESET — Resets FIREKIT's internal stopwatch timer to 0. The ELAPSED command displays elapsed time since the most recent RESET (or since program startup). The stopwatch is useful for timing FIREKIT command sequences.

SAVE — Saves the current fuel array to the designated raster fuel map file. The file must not exist when SAVE is issued. The current USER, DESCRIPTION, SPAN, and fuel array are written to the file. The fuel_id, template switch, ignited switch, and burned-out switch are recorded for each cell.

SCATTER — Randomly assigns the designated fuel_ids to cells according to the specified probabilities and FIREKIT command scoping rules.

SCREEN — Displays or sets the screen foreground and background colors. See the COLOR command for valid color names.

SCRIPT — Reads and processes the designated FIREKIT command script file. Script files may be nested up to 10 levels deep. Upon reaching a script end-of-file, control is returned to the previous script file or, utlimately. to the standard input device (keyboard).

SEED — Reseeds the random number generator used by the COVER and SCATTER commands. If no argument is given, the system clock is used to generate a seed value. If an argument is provided, it is used as the root for a new seed value.

SEND — Sends one or more ASCII values to the designated file. Primarily intended for sending printer control characters to output files.

SHELL — Loads the MS-DOS command shell and presents the DOS prompt. You may execute a series of small DOS commands. Enter 'EXIT' to return to FIREKIT.

SLOPE — Displays or sets the current terrain percent slope.

SPAN — Displays or sets the current map SPAN to the designated number of columns and rows. Legal limits are 140 columns by 100 rows.

SPREAD — Calculates and displays the current fire spread and intensity statistics during BURN or GBURN processing. Output may optionally be directed to the designated disk file.

Output includes the simulation time, a cell fire status frequency table, a spread and intensity descriptive statistics table, and a spread and fireline intensity percentiles table.

Note that spread statistics are valid only for strip fires ignited along the bottom edge of the map.

The SPREAD report may be printed from BURN and GBURN at periodic intervals via the REPORT SPREAD command.

SQUARE — Switches the template bits of all cells lying within the designated square according to FIREKIT command scoping rules.

SYMBOL — Displays or sets the symbols associated with fuel_ids, burning and burned cells, and the interactive draw mode. The fuel_ids are referenced by numbers 0-15. Burning and burned cells are referenced by number 16 and 17, respectively. The interactive draw color is referenced by number 18.

The symbols are used during PLOT output, and may be any printable ASCII character.

TEMPLATE — Displays, clears, or sets the TEMPLATE switch ON or OFF. When TEMPLATE is ON, default scoping is restricted to cells whose template bit is on. When TEMPLATE is OFF, default scoping is unrestricted. Default scoping is always overridden by explicit command scoping operators.

The TEMPLATE CLEAR command is identical to the CLEAR command; it switches OFF the template bits of all cells in the map.

TERRAIN — Displays or sets the current terrain percent slope and aspect bearing.

TEXTMODE — Switches FIREKIT into TEXTMODE. Used primarily during BATCH processing to return from a VIEW or GBURN command. During INTERACTIVE mode, pressing the <Esc> key performs the same function.

TIME — Displays the system time. Output may optionally be directed to the designated disk file.

TYPE — Displays the designated MS-DOS text files to the console.

UNDIRECT — Terminates the REDIRECT command and restores output to the terminal.

UNDO — Restores the fuel array to its previous condition. Un-does the effects of the most recent command that altered any cells' fuel_id or template bit.

UNITS — Displays or sets the current units of measures. Valid arguments are ENGLISH, FORESTRY, and METRIC. The command currently has no effect on inputs or outputs.

UPDATE — Updates the VIEW display fuel map without redrawing the entire display screen. Primarily used during BATCH processing.

USER — Displays or sets the 1-16 character USER name.

VELOCITY — Displays or sets the current wind velocity in miles per hour.

VERSION — Displays the FIREKIT startup banner containing the version number and date. Output may optionally be directed to the designated disk file.

VIDEO — Displays or sets the graphics monitor video type. Valid argument are:

EGA 640x350 16-color standard EGA
CVGA 640x480 16-color Compaq standard VGA
VEGA 640x480 16-color Vega Video 7 enhanced EGA

VIEW

Presents a graphical display of the current fuel map.

Return to TEXTMODE by pressing the <Esc> key.

Query cell attributes by moving the arrow cursor. Cursor movement in eight directions is controlled by the numeric keypad.

Pan and scroll the map by moving the arrow cursor to the edge.

Increase or decrease the magnification factor by pressing the '>' or '<' keys, respectively.

Draw designs by toggling the PenUp/PenDown < 1> key to turn on cell template bits. Toggle it again to move the cursor.

Erase a portion of the drawing by toggling the Draw/Erase < 2> key. Toggle it again to return to Draw mode.

Save the current drawing (e.g., set the template bits of drawn cells) by pressing the Save < 3> key.

Clear (erase) the current drawing by pressing the Clear < 4> key.

The DESCRIPTION string appears at the top of the display screen.

The MESSAGE string appears at the top of the map window.

WIND

Displays or sets the current wind velocity and bearing. Velocity is expressed in miles per hour. Bearing is the direction of wind travel expressed as compass degrees.

WRITE

Appends the designated string to the designated disk file. Primarily sued to insert comments into output files.

RASTER FUEL MAPS

Raster fuel map (RFM) files contain general fuel map documentation and individual fuel cell data. RFM's are created by the SAVE command, and accessed by the LOAD, OVERLAY, PASTE, and PEEK commands. RFM's are deleted by the DELETE command, and renamed by the RENAME command.

An RFM file contains a 128-byte header block followed by the fuel cell map (table 1). The header block contains the FIREKIT version label 'FIREKIT 2.0', the USER and DESCRIPTION strings, number of map columns and rows, and fire simulation time. The stored values are the current values at the time of the SAVE command.

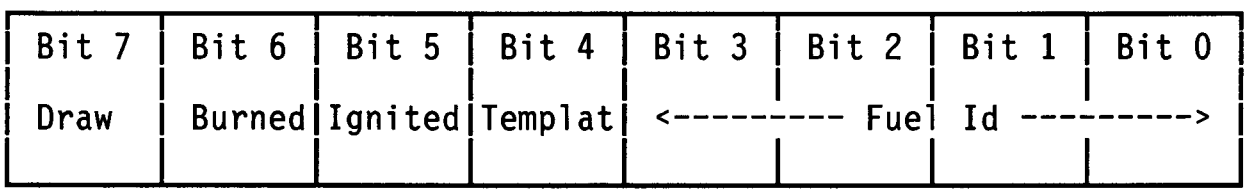
The fuel cell map data follow the header block. There is one byte per cell. The number of cells is determined by the most recent SPAN command in effect at SAVE time.

Fuel cell bytes contain 5 bit subfields (figure 1). Bits 0-3 contain the fuel_id [0-15]. Bit 4 is the 'template' bit. Bit 5 is the 'ignited' bit and bit 6 is the 'burned' bit. Bits 5 and 6 are cleared at the start of a fire simulation. Bit 5 is set when the cell is ignited, either by the simulation or by the user interactively using the torch. Bit 6 is set when the cell burns out. Bit 7 is the 'draw' bit, which is set during interactive drawing (using the pencil, shovel, or torch). It is cleared by the < 3> Store and < 4> Clear keys.

Raster Fuel Map File Format
Table 1

Field	Bytes	Type	Contents
1	001-000	A16	FIREKIT version id ("FIREKIT 2.0")
2	017-032	A16	USER string
3	033-112	A80	DESCRIPTION string
4	113-114	I2	SPAN columns
5	115-116	I2	SPAN rows
6	117-120	R4	Fire simulation time (minutes)
7	121-128	A8	Reserved
8	129-129	I2	Fuel cell column 1, row 1
9	130-130	I2	Fuel cell column 2, row 1
7+n	128+n	I2	Fuel cell column c, row r, where n = c*r

Fuel Cell Bit Map
Figure 1



Fuel Model Catalog File

The Fuel Model Catalog File contains standard and custom fuel models identified by a 1- to 8-character label. The FUEL command associates fuel ids with specific fuel models via the label. The ATTACH MODEL command defines the Fuel Model Catalog File to be accessed. The default Fuel Model Catalog File, FIREKIT.MOD, contains the 13 standard NFFL fuel models (figure 2).

Custom fuel models are added to a Fuel Model Catalog File using any ASCII text editor. The file begins with the FIREKIT version record containing 'FIREKIT 2.0'. This is followed by one or more blocks of data, one block per fuel model.

The first record of a fuel model block contains the 1- to 8-character fuel model label preceded by the '@' character. If the label is less than 8 characters in length, it must be blank filled. The remainder of the record is ignored.

The second record of the fuel model block contains the fuel model title or description.

The third record contains three data fields in free-field format;

- -- fuel bed depth (feet),
- -- extinction moisture content (fraction), and
- -- the number of fuel particle types.

The remaining records of the fuel model block describe the fuel particles. There is one record for each fuel particle. The record contains 7 fields in free-field format;

- -- Dead ('D') or live ('L') indicator,
- -- surface area-to-volume ratio (1/ft),
- -- fuel mass (lbs/sqft),
- -- low heat of combustion (BTU/lb),
- -- fuel particle density (lbs/cuft),
- -- mineral content (fraction oven-dry weight), and
- -- silica-free mineral content (fraction oven-dry weight).

All records are free-field format, and information past the last data field is ignored.

Figure 2 shows the standard NFFL fuel models contained in FIREKIT.MOD.

FIREKIT.MOD
Figure 2

```
FIREKIT 2.0
NOFUEL  ------------------------------
No Fuel Present
0.00  0. 1
0    0. 0.0000    0.  0.0 0.0000 0.0000
NFFL01  ------------------------------
Short Grass (1 ft)
1.00 12. 1
D 3500. 0.0340 8000. 32.0 0.0555 0.0100
NFFL02  ------------------------------
Timber (Grass and Understory)
1.00 15. 4
D 3000. 0.0920 8000. 32.0 0.0555 0.0100
D  109. 0.0460 8000. 32.0 0.0555 0.0100
D   30. 0.0230 8000. 32.0 0.0555 0.0100
L 1500. 0.0230 8000. 32.0 0.0555 0.0100
NFFL03  ------------------------------
Tall Grass (2.5 ft)
2.50 25. 1
D 1500. 0.1380 8000. 32.0 0.0555 0.0100
NFFL04  ------------------------------
Chaparral (6 ft)
6.00 20. 4
D 2000. 0.2300 8000. 32.0 0.0555 0.0100
D  109. 0.1840 8000. 32.0 0.0555 0.0100
D   30. 0.0920 8000. 32.0 0.0555 0.0100
L 1500. 0.2300 8000. 32.0 0.0555 0.0100
NFFL05  ------------------------------
Brush (2 ft)
2.00 20. 3
D 2000. 0.0460 8000. 32.0 0.0555 0.0100
D  109. 0.0230 8000. 32.0 0.0555 0.0100
L 1500. 0.0920 8000. 32.0 0.0555 0.0100
NFFL06  ------------------------------
Dormant Brush, Hardwood Slash
2.50 25. 3
D 1750. 0.0690 8000. 32.0 0.0555 0.0100
D  109. 0.1150 8000. 32.0 0.0555 0.0100
D   30. 0.0920 8000. 32.0 0.0555 0.0100
NFFL07  ------------------------------
Southern Rough
2.50 40. 4
D 1750. 0.0520 8000. 32.0 0.0555 0.0100
D  109. 0.0860 8000. 32.0 0.0555 0.0100
D   30. 0.0690 8000. 32.0 0.0555 0.0100
L 1550. 0.0170 8000. 32.0 0.0555 0.0100
NFFL08  ------------------------------
Closed Timber Litter
0.20 30. 3
D 2000. 0.0690 8000. 32.0 0.0555 0.0100
D  109. 0.0460 8000. 32.0 0.0555 0.0100
D   30. 0.1150 8000. 32.0 0.0555 0.0100
NFFL09  ------------------------------
Hardwood Litter
0.20 25. 3
D 2500. 0.1340 8000. 32.0 0.0555 0.0100
D  109. 0.0190 8000. 32.0 0.0555 0.0100
D   30. 0.0070 8000. 32.0 0.0555 0.0100
NFFL10  ------------------------------
Timber (Litter and Understory)
1.00 25. 4
D 2000. 0.1380 8000. 32.0 0.0555 0.0100
D  109. 0.0920 8000. 32.0 0.0555 0.0100
D   30. 0.2300 8000. 32.0 0.0555 0.0100
L 1500. 0.0920 8000. 32.0 0.0555 0.0100
NFFL11  ------------------------------
Light Logging Slash
1.00 15. 3
D 1500. 0.0690 8000. 32.0 0.0555 0.0100
D  109. 0.2070 8000. 32.0 0.0555 0.0100
D   30. 0.2530 8000. 32.0 0.0555 0.0100
NFFL12  ------------------------------
Medium Logging Slash
2.30 20. 3
D 1500. 0.1640 8000. 32.0 0.0555 0.0100
D  109. 0.6440 8000. 32.0 0.0555 0.0100
D   30. 0.7590 8000. 32.0 0.0555 0.0100
NFFL13  ------------------------------
Heavy Logging Slash
3.00 25. 3
D 1500. 0.3220 8000. 32.0 0.0555 0.0100
D  109. 1.0580 8000. 32.0 0.0555 0.0100
D   30. 1.2880 8000. 32.0 0.0555 0.0100
```

SAMPLE SCRIPTS

This section documents three sample FIREKIT scripts and their text output:

IMP_SAGE.SCR — Imports the three digitized sagebrush photos and stores them in Raster Fuel Map files.

BURNSAGE.SCR — Initializes fire environment conditions, starts a line fire along the southern edge of SAGE2.RFM, and prints spread statistics every few minutes. The burn is paused to change weather conditions, start a spot fire, and continue burning.

URBANDEM.SCR — Imports digitized maps and reads script files to produce a sample forest-urban interface map within which a fire is started. This script employs self-running demonstration techniques.

To run a sample script, start FIREKIT and issue one of the SCRIPT commands:

```
?> SCRIPT IMP_SAGE.SCR

?> SCRIPT BURNSAGE.SCR

?> SCRIPT URBANDEM.SCR
```

It is important that import and script file directories referenced by the scripts exist on your system.

The contents of each script file is displayed here, followed by its text output as captured by the LOGFILE command.

IMP_SAGE.SCR

```
* ------------------------------------------------------------------------
* Script file to import and save the 3 Sagebrush Photos
* C.Bevins  May 1989
* ------------------------------------------------------------------------
*
* ------------------------------------------------------------------------
* First open a log file and set the environment.
* ------------------------------------------------------------------------
*
LOGFILE IMP_SAGE.LOG
PROMPT  OFF
ABORT   ON
ECHO    ON
USER    P.Andrews
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 1 (126 x 85 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 1: 1=Background, 2=ARTR1, 3=PUTR1
SPAN    126 85
COVER   1 100
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
IMPORT  \FUELDATA\SAGE\ARTR1.IMP
COVER+  2 100
* Import PUTR into fuel map template and assign it fuel_id 3.
CLEAR
IMPORT  \FUELDATA\SAGE\PUTR1.IMP
COVER+  3 100
* Clear the template before saving the fuel map.
CLEAR
DELETE  SAGE1.RFM
SAVE    SAGE1.RFM
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 2 (133 x 92 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 2: 1=Background, 2=ARTR4, 3=ARTR2, 4=PUTR2
SPAN    133 92
COVER   1 100
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
IMPORT  \FUELDATA\SAGE\ARTR4.IMP
COVER+  2 100
* Import ARTR into fuel map template and assign it fuel_id 3.
CLEAR
IMPORT  \FUELDATA\SAGE\ARTR2.IMP
COVER+  3 100
* Import PUTR into fuel map template and assign it fuel_id 4.
CLEAR
IMPORT  \FUELDATA\SAGE\PUTR2.IMP
COVER+  4 100
* Clear the template before saving the fuel map.
CLEAR
DELETE  SAGE2.RFM
SAVE    SAGE2.RFM
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 3 (137 x 92 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 3: 1=Bg, 2=ARTR3, 3=PUTR3
SPAN    137 92
COVER   1 100
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
IMPORT  \FUELDATA\SAGE\ARTR3.IMP
COVER+  2 100
* Import PUTR into fuel map template and assign it fuel_id 3.
IMPORT  \FUELDATA\SAGE\PUTR3.IMP
CLEAR
COVER+  3 100
* Clear the template before saving the fuel map.
CLEAR
DELETE  SAGE3.RFM
SAVE    SAGE3.RFM
*
* ------------------------------------------------------------------------
* Turn off the log file and restore the environment before returning
* control to the keyboard.
* ------------------------------------------------------------------------
*
ABORT   OFF
ECHO    OFF
PROMPT  ON
LOGFILE OFF
```

IMP_SAGE.LOG

```
New LOG file opened.
PROMPT switched OFF.
ABORT switched ON.
ECHO switched ON.
USER    P.Andrews
USER set to [P.Andrews].
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 1 (126 x 85 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 1: 1=Background, 2=ARTR1, 3=PUTR1
DESCRIPTION set to [Sagebrush Photo 1: 1=Background, 2=ARTR1, 3=PUTR1].
SPAN    126 85
SPAN set to 126 columns by  85 rows.
COVER   1 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     1       10710     1.000000
  -------  ---------  ----------
  Totals     10710     1.000000
---------------------------------
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\ARTR1.IMP
ELLIPSE   000101  artr1.dat
The following imported features were SET     :
ELLIPSES:    101
COVER+  2 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     2        1478     1.000000
  -------  ---------  ----------
  Totals      1478     1.000000
---------------------------------
* Import PUTR into fuel map template and assign it fuel_id 3.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\PUTR1.IMP
ELLIPSE   000010  putr1.dat
The following imported features were SET     :
ELLIPSES:     10
COVER+  3 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     3          70     1.000000
  -------  ---------  ----------
  Totals        70     1.000000
---------------------------------
* Clear the template before saving the fuel map.
CLEAR
TEMPLATE has been CLEARED.
DELETE  SAGE1.RFM
SAGE1.RFM deleted.
SAVE    SAGE1.RFM
 10710 cell SAVEd to RFM SAGE1.RFM
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 2 (133 x 92 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 2: 1=Background, 2=ARTR4, 3=ARTR2, 4=PUTR2
DESCRIPTION set to [Sagebrush Photo 2: 1=Background, 2=ARTR4, 3=ARTR2, 4=PUTR2].
SPAN    133 92
SPAN set to 133 columns by  92 rows.
COVER   1 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     1       12236     1.000000
  -------  ---------  ----------
  Totals     12236     1.000000
---------------------------------
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\ARTR4.IMP
ELLIPSE   000367  artr4.dat
The following imported features were SET     :
ELLIPSES:    367
COVER+  2 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     2        4148     1.000000
  -------  ---------  ----------
  Totals      4148     1.000000
---------------------------------
* Import ARTR into fuel map template and assign it fuel_id 3.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\ARTR2.IMP
ELLIPSE   000025  artr2.dat
The following imported features were SET     :
ELLIPSES:     25
COVER+  3 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     3         637     1.000000
  -------  ---------  ----------
  Totals       637     1.000000
---------------------------------
* Import PUTR into fuel map template and assign it fuel_id 4.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\PUTR2.IMP
ELLIPSE   000008  putr2.dat
The following imported features were SET     :
ELLIPSES:      8
COVER+  4 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     4          60     1.000000
  -------  ---------  ----------
  Totals        60     1.000000
---------------------------------
* Clear the template before saving the fuel map.
CLEAR
TEMPLATE has been CLEARED.
DELETE  SAGE2.RFM
SAGE2.RFM deleted.
SAVE    SAGE2.RFM
 12236 cell SAVEd to RFM SAGE2.RFM
*
* ------------------------------------------------------------------------
* Import Sagebrush Photo 3 (137 x 92 ft) over a background of fuel_id 1.
* ------------------------------------------------------------------------
*
DESCR   Sagebrush Photo 3: 1=Bg, 2=ARTR3, 3=PUTR3
DESCRIPTION set to [Sagebrush Photo 3: 1=Bg, 2=ARTR3, 3=PUTR3].
SPAN    137 92
SPAN set to 137 columns by  92 rows.
COVER   1 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     1       12604     1.000000
  -------  ---------  ----------
  Totals     12604     1.000000
---------------------------------
* Import ARTR into fuel map template and assign it fuel_id 2.
CLEAR
TEMPLATE has been CLEARED.
IMPORT  \FUELDATA\SAGE\ARTR3.IMP
ELLIPSE   000534  artr3.dat
The following imported features were SET     :
ELLIPSES:    534
COVER+  2 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     2        6940     1.000000
  -------  ---------  ----------
  Totals      6940     1.000000
---------------------------------
* Import PUTR into fuel map template and assign it fuel_id 3.
IMPORT  \FUELDATA\SAGE\PUTR3.IMP
ELLIPSE   000012  putr3.dat
The following imported features were SET     :
ELLIPSES:     12
CLEAR
TEMPLATE has been CLEARED.
COVER+  3 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     3          0     0.000000
  -------  ---------  ----------
  Totals        0     0.000000
---------------------------------
* Clear the template before saving the fuel map.
CLEAR
TEMPLATE has been CLEARED.
DELETE  SAGE3.RFM
SAGE3.RFM deleted.
SAVE    SAGE3.RFM
 12604 cell SAVEd to RFM SAGE3.RFM
*
* ------------------------------------------------------------------------
* Turn off the log file and restore the environment before returning
* control to the keyboard.
* ------------------------------------------------------------------------
*
ABORT   OFF
ABORT switched OFF.
ECHO    OFF
ECHO switched OFF.
PROMPT switched ON.
```

URBANDEM.SCR

```
* ------------------------------------------------------------------------
* Sample Forest/Urban Interface Fuel Map Creation Script
* C.Bevins May 1989
* ------------------------------------------------------------------------
*
* ------------------------------------------------------------------------
* First open a log file and set the environment.
* ------------------------------------------------------------------------
*
DELETE  URBANDEMO.LOG
REDIRECT URBANDEM.LOG
PROMPT  OFF
DELETE  URBAN015.RFM
DELETE  URBAN015.PLT
DELETE  URBAN030.RFM
DELETE  URBAN030.PLT
ABORT   ON
ECHO    ON
*
RESET
USER    C.Bevins
DESCR   Sample Forest-Urban Interface Fuel Map
SPAN    100 100
MAGNIFY FULL
*
* ------------------------------------------------------------------------
* Timber is fuel_id 1, solid brown, symbol 'T'
* Grass is fuel_id 2, solid green, symbol 'G'
* Water is fuel_id 3, solid blue, symbol 'W'
* Roads are fuel_id 4, solid red, symbol 'R'
* Houses are fuel_id 5, sold magenta, symbol 'H'
* ------------------------------------------------------------------------
*
LEGEND  1 BROWN 1 T, 2 GREEN 1 G, 3 BLUE 1 W, 4 RED 1 R, 5 MAGENTA 1 H
*
* ------------------------------------------------------------------------
* Make Timber the 'background' fuel_id 1.
* Assign fuel_id 1 to NFFL02 Timber and Litter.
* Display the timber fuel background and pause for 1 second.
* ------------------------------------------------------------------------
*
CONVERT 0 1
FUEL    1 NFFL02
PAUSE   1
PAUSE   ON
MESSAGE Use Timber Fuels as Background
VIEW
*
* ------------------------------------------------------------------------
* Import RIPARIAN.IMP map.
* Convert the imported template to fuel_id 2.
* Assign fuel_id 2 to NFFL01 Short Grass.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
IMPORT  riparian.imp
COVER+  2 100
FUEL    2 NFFL01
MESSAGE Riparian Fuel Added
UPDATE
*
* ------------------------------------------------------------------------
* Import WATER.IMP map defining the lake and stream.
* Convert the imported template to fuel_id 3.
* Assign fuel_id 3 to NOFUEL.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
IMPORT  water.imp
COVER+  3 100
FUEL    3 NOFUEL
MESSAGE Lake and Stream Added
UPDATE
*
* ------------------------------------------------------------------------
* Import ROADS.IMP map defining the road network.
* Convert the imported template to fuel_id 4.
* Assign fuel_id 4 to NOFUEL.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
IMPORT  roads.imp
COVER+  4 100
FUEL    4 NOFUEL
MESSAGE Road Network Added
UPDATE
*
* ------------------------------------------------------------------------
* Build houses using commands from the HOUSES.SCR script file.
* Convert the imported template to fuel_id 5.
* Assign fuel_id 5 to NFFL13 Heavy Slash.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
SCRIPT  houses.scr
COVER+  5 100
FUEL    5 NFFL13
MESSAGE Houses Added
UPDATE
*
* ------------------------------------------------------------------------
* Stop pause and setup fire environment.
* Start a fire at cell(21,71).
* Let fire burn for 15 minutes.
* ------------------------------------------------------------------------
*
PAUSE   OFF
ELAPSED
RESET
MOISTUR 4 6 8 50 50
WIND    4 120
CLEAR
CELL    21 71
MESSAGE Fire Start at (21,71), Wind at 4 mph bearing 120
GBURN   UNTIL TIME 15
*
* ------------------------------------------------------------------------
* Save the current fire/fuel map, and generate a plot of it.
* Change wind direction to southerly.
* Let burn for another 15 minutes, then stop.
* ------------------------------------------------------------------------
*
SAVE    URBAN015.RFM
DISPLAY FIRE
PANEL   100 100
PLOT    URBAN015.PLT
BEARING 180
MESSAGE Wind bearing changed to 180
GCONT   UNTIL TIME 30
TEXTMODE
SAVE    URBAN030.RFM
PLOT    URBAN030.PLT
*
* ------------------------------------------------------------------------
* Stop redirection and restore the environment.
* ------------------------------------------------------------------------
*
ELAPSED
PROMPT  ON
ABORT   OFF
ECHO    OFF
UNDIRECT
```

URBANDEM.LOG

```
?
PROMPT switched OFF.
*** URBAN015.RFN not found.
*** URBAN015.PLT not found.
*** URBAN030.RFN not found.
*** URBAN030.PLT not found.
ABORT switched ON.
ECHO switched ON.
*
RESET
Timer reset to 0.
USER    C.Bevins
USER set to [C.Bevins].
DESCR   Sample Forest-Urban Interface Fuel Map
DESCRIPTION set to [Sample Forest-Urban Interface Fuel Map].
SPAN    100 100
SPAN set to 100 columns by 100 rows.
MAGNIFY FULL
MAGNIFY set to   4.
*
* ------------------------------------------------------------------------
* Timber is fuel_id 1, solid brown, symbol 'T'
* Grass is fuel_id 2, solid green, symbol 'G'
* Water is fuel_id 3, solid blue, symbol 'W'
* Roads are fuel_id 4, solid red, symbol 'R'
* Houses are fuel_id 5, solid magenta, symbol 'H'
* ------------------------------------------------------------------------
*
LEGEND  1 BROWN 1 T, 2 GREEN 1 G, 3 BLUE 1 W, 4 RED 1 R, 5 MAGENTA 1 H
------------------------------
     VIEW/PLOT Fuel Legend
------------------------------
Fuel   Color    Pattern  Symbol
----  --------  -------  ------
  1   BROWN         1       T
  2   GREEN         1       G
  3   BLUE          1       W
  4   RED           1       R
  5   MAGENTA       1       H
------------------------------
*
* ------------------------------------------------------------------------
* Make Timber the 'background' fuel_id 1.
* Assign fuel_id 1 to NFFL02 Timber and Litter.
* Display the timber fuel background and pause for 1 second.
* ------------------------------------------------------------------------
*
CONVERT 0 1
--------------------
Fuel_id Conversions
 Old  New   Cells
 ---  ---  -------
  0    1   10000
--------------------
FUEL    1 NFFL02
-----------------------------------------------------
              Fuel Model Table
-----------------------------------------------------
Fuel  Model     Description
----  --------  ---------------------------------------
  1   NFFL02    Timber (Grass and Understory)
-----------------------------------------------------
PAUSE   1
PAUSE set to   1 seconds.
PAUSE   ON
PAUSE switched ON at   1 seconds.
MESSAGE Use Timber Fuels as Background
MESSAGE set to [Use Timber Fuels as Background].
VIEW
*
* ------------------------------------------------------------------------
* Import RIPARIAN.IMP map.
* Convert the imported template to fuel_id 2.
* Assign fuel_id 2 to NFFL01 Short Grass.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
TEMPLATE has been CLEARED.
IMPORT  riparian.imp
POLYGON   000029  Riparian Area in Urban-Forest Interface
The following imported features were SET     :
POLYGONS:     1
COVER* 2 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     2        2839     1.000000
  -------  ---------  ----------
  Totals      2839     1.000000
---------------------------------
FUEL    2 NFFL01
-----------------------------------------------------
              Fuel Model Table
-----------------------------------------------------
Fuel  Model     Description
----  --------  ---------------------------------------
  2   NFFL01    Short Grass (1 ft)
-----------------------------------------------------
MESSAGE Riparian Fuel Added
MESSAGE set to [Riparian Fuel Added].
UPDATE
*
* ------------------------------------------------------------------------
* Import WATER.IMP map defining the lake and stream.
* Convert the imported template to fuel_id 3.
* Assign fuel_id 3 to NOFUEL.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
TEMPLATE has been CLEARED.
IMPORT  water.imp
POLYGON   000024  Lake in Urban-Forest Interface
LINE      000009  Stream in Urban-Forest Interface
The following imported features were SET     :
LINES   :     1
POLYGONS:     1
COVER* 3 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     3        786     1.000000
  -------  ---------  ----------
  Totals      786     1.000000
---------------------------------
FUEL    3 NOFUEL
-----------------------------------------------------
              Fuel Model Table
-----------------------------------------------------
Fuel  Model     Description
----  --------  ---------------------------------------
  3   NOFUEL    No Fuel Present
-----------------------------------------------------
MESSAGE Lake and Stream Added
MESSAGE set to [Lake and Stream Added].
UPDATE
*
* ------------------------------------------------------------------------
* Import ROADS.IMP map defining the road network.
* Convert the imported template to fuel_id 4.
* Assign fuel_id 4 to NOFUEL.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
TEMPLATE has been CLEARED.
IMPORT  roads.imp
LINE      000013  Road 1 in Urban-Forest Interface
LINE      000002  Road 2 in Urban-Forest Interface
LINE      000013  Road 3 in Urban-Forest Interface
The following imported features were SET     :
LINES   :     3
COVER* 4 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
  -------  ---------  ----------
     4        235     1.000000
  -------  ---------  ----------
  Totals      235     1.000000
---------------------------------
FUEL    4 NOFUEL
-----------------------------------------------------
              Fuel Model Table
-----------------------------------------------------
Fuel  Model     Description
----  --------  ---------------------------------------
  4   NOFUEL    No Fuel Present
-----------------------------------------------------
MESSAGE Road Network Added
MESSAGE set to [Road Network Added].
UPDATE
*
* ------------------------------------------------------------------------
* Build houses using commands from the HOUSES.SCR script file.
* Convert the imported template to fuel_id 5.
* Assign fuel_id 5 to NFFL13 Heavy Slash.
* Update the VIEW (pause is still in effect).
* ------------------------------------------------------------------------
*
CLEAR
TEMPLATE has been CLEARED.
SCRIPT  houses.scr
SCRIPT file opened.
rectangle 54 08 02 01
     2 cells in template RECTANGLE were SET
rectangle 55 21 01 03
     3 cells in template RECTANGLE were SET
rectangle 53 43 01 02
     2 cells in template RECTANGLE were SET
rectangle 53 53 01 02
     2 cells in template RECTANGLE were SET
rectangle 64 46 01 02
     2 cells in template RECTANGLE were SET
rectangle 66 60 01 02
     2 cells in template RECTANGLE were SET
rectangle 46 66 01 02
     2 cells in template RECTANGLE were SET
rectangle 56 74 02 01
     2 cells in template RECTANGLE were SET
rectangle 23 13 01 02
     2 cells in template RECTANGLE were SET
rectangle 27 24 01 02
     2 cells in template RECTANGLE were SET
rectangle 32 33 01 02
     2 cells in template RECTANGLE were SET
rectangle 37 50 01 02
     2 cells in template RECTANGLE were SET
rectangle 35 73 01 02
     2 cells in template RECTANGLE were SET
rectangle 35 85 02 01
     2 cells in template RECTANGLE were SET
rectangle 22 82 01 02
     2 cells in template RECTANGLE were SET
rectangle 29 93 02 01
     2 cells in template RECTANGLE were SET
COVER* 5 100
---------------------------------
     COVER Fuel Assignments
  Fuel_id  No. Cells  Proportion
```

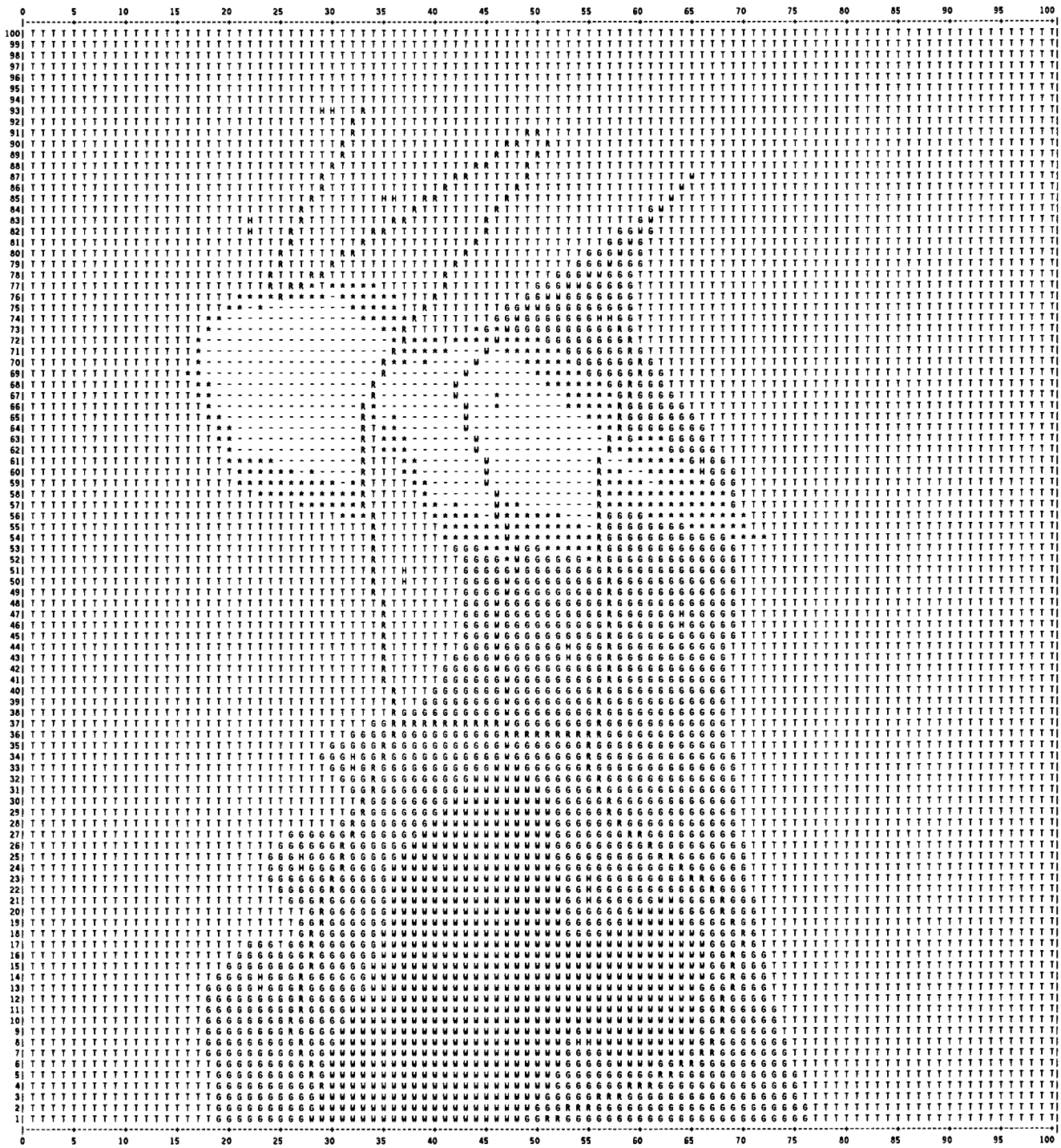
```
-------  ---------  ----------
   5          33     1.000000
-------  ---------  ----------
Totals        33     1.000000
-----------------------------------
FUEL    5 NFFL13
------------------------------------------------------------
             Fuel Model Table
------------------------------------------------------------
Fuel  Model     Description
----  --------  -----------------------------------------
  5   NFFL13    Heavy Logging Slash
------------------------------------------------------------
MESSAGE Houses Added
MESSAGE set to [Houses Added].
UPDATE
*
* ---------------------------------------------------------------------------
* Stop pause and setup fire environment.
* Start a fire at cell(21,71).
* Let fire burn for 15 minutes.
* ---------------------------------------------------------------------------
*
PAUSE   OFF
PAUSE switched OFF at   1 seconds.
ELAPSED
Elapsed time is    23.12 seconds.
RESET
Timer reset to 0.
MOISTUR 4 6 8 50 50
------------------------
    Fuel Moistures
------------------------
1-hr % moisture     4.00
10-hr % moisture    6.00
100-hr % moisture   8.00
Herb % moisture    50.00
Woody % moisture   50.00
------------------------
WIND    4 120
-----------------
   Wind Values
Parameter   Value
----------- -----
Speed (mph)   4.0
Bearing (o) 120.0
-----------------
CLEAR
TEMPLATE has been CLEARED.
CELL    21 71
The CELL was SET
MESSAGE Fire Start at [21,71], Wind at 4 mph bearing 120
MESSAGE set to [Fire Start at [21,71], Wind at 4 mph bearing 120].
GBURN   UNTIL TIME 15
Back in TEXT mode.
*
* ---------------------------------------------------------------------------
* Save the current fire/fuel map, and generate a plot of it.
* Change wind direction to southerly.
* Let burn for another 15 minutes, then stop.
* ---------------------------------------------------------------------------
*
SAVE    URBAN015.RFM
 10000 cell SAVEd to RFM URBAN015.RFM
DISPLAY FIRE
DISPLAY switched to FIRE.
PANEL   100 100
PLOT PANEL set to 100 columns by 100 rows.
PLOT    URBAN015.PLT
PLOT printed to file.
BEARING 180
Wind bearing changed to 180.00 degrees.
MESSAGE Wind bearing changed to 180
MESSAGE set to [Wind bearing changed to 180].
GCONT   UNTIL TIME 30
Back in TEXT mode.
TEXTMODE
SAVE    URBAN030.RFM
 10000 cell SAVEd to RFM URBAN030.RFM
PLOT    URBAN030.PLT
PLOT printed to file.
*
* ---------------------------------------------------------------------------
* Stop redirection and restore the environment.
* ---------------------------------------------------------------------------
*
ELAPSED
Elapsed time is   999.86 seconds.
PROMPT  ON
PROMPT switched ON.

?
ABORT   OFF
ABORT switched OFF.

?
ECHO    OFF
ECHO switched OFF.
```

URBAN015.PLT

Version : FIREKIT 2.0 View Port: Entire Array
Descript: Sample Forest-Urban Interface Fuel Map User: C.Bevins Strip :01 of 01 Page : 01 of 01



BURNSAGE.SCR

```
* ------------------------------------------------------------------------
* Sample script to burn a strip fire in SAGE3.RFM.
* C.Bevins May 1989
* ------------------------------------------------------------------------
*
* ------------------------------------------------------------------------
* First open a log file and set the environment.
* ------------------------------------------------------------------------
*
DELETE   BURNSAGE.LOG
DELETE   BURNSAGE.REP
REDIRECT BURNSAGE.LOG
PROMPT   OFF
ABORT    ON
ECHO     ON
*
* ------------------------------------------------------------------------
* Load SAGE3.RFM and assign fuels and fire environment.
* The background fuel is NFFL02, with sage represented by Chaparral (NFFL04).
* ------------------------------------------------------------------------
*
RESET
LOAD     SAGE3.RFM
MAGNIFY  FULL
FUEL     1 NFFL02 2 NFFL04 3 NFFL04
MOISTURE 6 10 14 50 50
WIND     4 0
*
* ------------------------------------------------------------------------
* Report the environment and combustion tables to BURNSAGE.REP.
* ------------------------------------------------------------------------
*
ENVIRONMENT      BURNSAGE.REP
COMBUSTION       BURNSAGE.REP
*
* ------------------------------------------------------------------------
* Start a strip fire and report fire statistics every minute.
* ------------------------------------------------------------------------
*
CLEAR
REPORT SPREAD 1. BURNSAGE.REP
LINE 1 1 150 1
GBURN UNTIL MINUTES 5
*
* ------------------------------------------------------------------------
* Restore operating environment.
* ------------------------------------------------------------------------
*
PROMPT  ON
ABORT   OFF
ECHO    OFF
UNDIRECT
```

BURNSAGE.LOG

```
?
PROMPT switched OFF.
ABORT switched ON.
ECHO switched ON.
*
* ------------------------------------------------------------------------
* Load SAGE3.RFM and assign fuels and fire environment.
* The background fuel is NFFL02, with sage represented by Chaparral (NFFL04).
* ------------------------------------------------------------------------
*
RESET
Timer reset to 0.
LOAD     SAGE3.RFM
 12604 cells LOADed from RFM SAGE3.RFM
MAGNIFY  FULL
MAGNIFY set to   2.
FUEL     1 NFFL02 2 NFFL04 3 NFFL04
-----------------------------------------------------
              Fuel Model Table
-----------------------------------------------------
Fuel  Model     Description
----  --------  ----------------------------------
  1   NFFL02    Timber (Grass and Understory)
  2   NFFL04    Chaparral (6 ft)
  3   NFFL04    Chaparral (6 ft)
-----------------------------------------------------
MOISTURE 6 10 14 50 50
------------------------
     Fuel Moistures
------------------------
1-hr % moisture     6.00
10-hr % moisture   10.00
100-hr % moisture  14.00
Herb % moisture    50.00
Woody % moisture   50.00
------------------------
WIND     4 0
-----------------
   Wind Values
Parameter   Value
---------- -----
Speed (mph)   4.0
Bearing (o)   0.0
-----------------
*
* ------------------------------------------------------------------------
* Report the environment and combustion tables to BURNSAGE.REP.
* ------------------------------------------------------------------------
*
ENVIRONMENT      BURNSAGE.REP
ENVIRONMENT table printed to file.
COMBUSTION       BURNSAGE.REP
COMBUSTION table printed to file.
*
* ------------------------------------------------------------------------
* Start a strip fire and report fire statistics every minute.
* ------------------------------------------------------------------------
*
CLEAR
TEMPLATE has been CLEARED.
REPORT SPREAD 1. BURNSAGE.REP
 Spread Rate variables will be printed every   1.00 minutes.
LINE 1 1 150 1
   137 cells were SET
GBURN UNTIL MINUTES 5
Back in TEXT mode.
*
* ------------------------------------------------------------------------
* Restore operating environment.
* ------------------------------------------------------------------------
*
PROMPT  ON
PROMPT switched ON.

?
ABORT   OFF
ABORT switched OFF.

?
ECHO    OFF
ECHO switched OFF.

?
```

BURNSAGE.REP

Fire Environment Table

Terrain	Aspect	(deg)	0.00
	Slope	(%)	0.00
Wind	Velocity	(mph)	4.00
	Bearing	(deg)	0.00
Moisture	1-hr dead	(%)	6.00
	10-hr dead	(%)	10.00
	100-hr dead	(%)	14.00
	Herbaceous	(%)	50.00
	Woody live	(%)	50.00
Fuel Cell	Diameter	(ft)	10.00
	Neighbors	(n)	6.00
	Penetration Calcs		Off
Fuel Model File			FIREKIT.MOD
	Fuel 1		NFFL02
	Fuel 2		NFFL04
	Fuel 3		NFFL04

Fuel Combustion Variables

Fuel Model	Tau (min)	Reaction Int (BTU/ft2/mn)	Dir (o)	Spread (ft/mn)	Wnd-Slp (dl)
NFFL02	0.1379	3549.13	60	2.97	1.005
			120	7.52	2.539
			180	31.81	10.746
			240	7.52	2.539
			300	2.97	1.005
			360	2.28	0.772
NFFL04	0.2208	12959.76	60	9.14	1.273
			120	23.10	3.218
			180	97.76	13.617
			240	23.10	3.218
			300	9.14	1.273
			360	7.02	0.978
NFFL04	0.2208	12959.76	60	9.14	1.273
			120	23.10	3.218
			180	97.76	13.617
			240	23.10	3.218
			300	9.14	1.273
			360	7.02	0.978

Fire Behavior Statistics at Time 1.00 minutes (000600 fire cycles).

Fuel Map Fire Status Table

Status	Cells	(%)
Unburned	11789	93.5
Burning	815	6.5
Burned Out	0	0.0

Fire Behavior Statistics Table

Var (Units)	Count	Mean	StFev	Minimum	Maximum
ROS (ft/min)	137.	53.09	19.17	31.75	98.31
FLI (BTU/ft-s)	137.	1907.70	2010.85	0.00	5601.34

Fire Behavior Percentiles Table

Percentile Level	Spread Rate (ft/min)	Intensity (BTU/ft/s)
10	31.75	84.74
20	31.75	410.67
30	31.75	517.87
40	50.00	517.87
50	51.14	517.87
60	60.00	577.46
70	62.23	4019.80
80	70.00	4688.44
90	80.00	4980.62
100	98.31	5601.34

Fire Behavior Statistics at Time 2.00 minutes (001200 fire cycles).

Fuel Map Fire Status Table

Status	Cells	(%)
Unburned	11028	87.5
Burning	1348	10.7
Burned Out	228	1.8

Fire Behavior Statistics Table

Var (Units)	Count	Mean	StFev	Minimum	Maximum
ROS (ft/min)	137.	54.53	14.77	31.75	88.58
FLI (BTU/ft-s)	137.	2002.94	2100.15	0.00	6141.11

Fire Behavior Percentiles Table

Percentile Level	Spread Rate (ft/min)	Intensity (BTU/ft/s)
10	35.69	0.00
20	41.41	81.55
30	43.26	487.37
40	47.36	517.87
50	50.93	517.87
60	56.92	1611.49
70	60.87	3259.33
80	67.51	4688.44
90	77.36	4969.68
100	88.58	6141.11

Fire Behavior Statistics at Time 3.00 minutes (001800 fire cycles).

Fuel Map Fire Status Table

Status	Cells	(%)
Unburned	10176	80.7
Burning	1812	14.4
Burned Out	616	4.9

Fire Behavior Statistics Table

Var (Units)	Count	Mean	StFev	Minimum	Maximum
ROS (ft/min)	137.	57.58	13.33	30.29	86.10
FLI (BTU/ft-s)	137.	1599.75	1738.52	0.00	6731.51

Fire Behavior Percentiles Table

Percentile Level	Spread Rate (ft/min)	Intensity (BTU/ft/s)
10	40.45	0.00
20	44.16	150.18
30	48.35	259.57
40	53.33	493.63
50	56.92	586.87
60	60.14	1549.23
70	64.48	2075.99
80	70.41	3007.69
90	74.11	4688.44
100	86.10	6731.51

Fire Behavior Statistics at Time 4.00 minutes (002400 fire cycles).

Fuel Map Fire Status Table

Status	Cells	(%)
Unburned	9337	74.1
Burning	2143	17.0
Burned Out	1124	8.9

Fire Behavior Statistics Table

Var (Units)	Count	Mean	StFev	Minimum	Maximum
ROS (ft/min)	137.	58.04	11.24	30.65	86.55
FLI (BTU/ft-s)	137.	1755.99	1994.86	0.00	7759.86

Fire Behavior Percentiles Table

Percentile Level	Spread Rate (ft/min)	Intensity (BTU/ft/s)
10	42.50	0.00
20	47.74	0.00
30	52.52	259.57
40	55.15	517.87
50	57.60	577.65
60	61.13	1302.36
70	65.03	2921.75
80	67.90	3957.12
90	70.81	4701.71
100	86.55	7759.86

6. UTILITIES

HEXPRINT

HEXPRINT prints hexagonal-cell fire status maps from Raster Fuel Map (RFM) files. Unburned cells are white, burning cells are black, and burned cells are grey. The program currently works only with a Toschiba P351 dot-matrix printer.

To run the program, type HEXPRINT at the DOS prompt. A printer menu is presented; enter 0 to quit, or 1 to print on a Toschiba P351.

You are next prompted for the number of hex columns per page. Enter 64 for 8.5-inch paper, and 100 for 14-inch paper.

The next prompt asks for the RFM file name. Type the name and press return. HEXPRINT attempts to open and read the file. If successful, it displays the RFM header information on the terminal and asks whether to continue. Type a 'c' or 'C' to continue, or any other character to quit.

HEXPRINT then begins printing. First the RFM header information is printed at the top of the page. Then all rows of the first 64 (or 100) hex columns are printed in graphics mode, followed by a page feed. The process is repeated for the next 64 (or 100) hex columns, until all columns are printed.